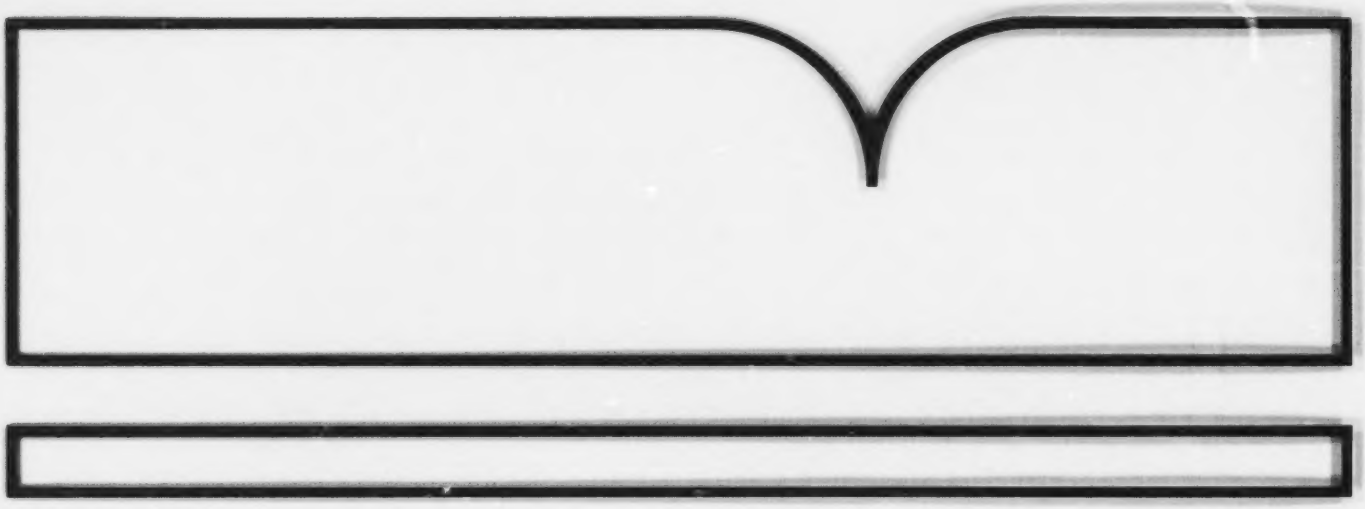
PB89-102578

# Pesticide Fact Sheet Number 94.2
# 2,4-Dichlorophenoxyacetic Acid

Environmental Protection Agency, Washington, DC

Sep 88



U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

| REPORT DOCUMENTATION PAGE | 1. REPORT NO. | 2. | 3. PB89-102578 |
|---|---|---|---|

**4. Title and Subtitle**

EPA Pesticide Fact Sheets - 2,4-Dichlorophenoxy- No. 94.2 acetic Acid

**5. Report Date** September 1988

**6.**

**7. Author(s)**

EPA, Office of Pesticide Programs, Registration Division

**8. Performing Organization Rept. No.** 540/FS-88-114

**9. Performing Organization Name and Address**

U.S. Environmental Protection Agency
Office of Pesticide Programs
Registration Division (TS-767C)
401 M Street, SW
Washington, D.C. 20460

**10. Project/Task/Work Unit No.**

**11. Contract(C) or Grant(G) No.**

(C)

(G)

**12. Sponsoring Organization Name and Address**

Same as #9

**13. Type of Report & Period Covered**

**14.**

**15. Supplementary Notes**

Supercedes PB87-192712

**16. Abstract (Limit: 200 words)**

This document contains up-to-date chemical information, including a summary of the Agency's regulatory position and rationale, on a specific pesticide or group of pesticides. A Fact Sheet is issued after one of the the following actions has occurred.

1. Issuance or reissuance of a registration standard,
2. Issuance of each special review document,
3. Registration of a significantly changed use pattern,
4. Registration of a new chemical, or
5. An immediate need for information to resolve controversial issues relating to a specific chemical or use pattern.

**17. Document Analysis a. Descriptors**

Pesticides, regulations, Chemical Information Fact Sheet, Use Patterns, science findings.

**b. Identifiers/Open-Ended Terms**

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

**c. COSATI Field/Group**

| 18. Availability Statement: | 19. Security Class (This Report) | 21. No. of Pages |
|---|---|---|
| Publicly Available | Unclassified | 14 |
| | 20. Security Class (This Page) Unclassified | 22. Price A03 12.95 |

United States
Environmental Protection
Agency

Office of Pesticides and Toxic Substances
Office of Pesticide Programs (TS-766C)
Washington, DC 20460

540/FS-88-114

EPA

# Pesticide Fact Sheet

Name of Chemical: 2,4-Dichlorophenoxyacetic Acid (2,4-D)
Reason for Issuance: Registration Standard
Date Issued: September 1988
Fact Sheet Number: 94.2

## DESCRIPTION OF CHEMICAL

Generic Name: 2,4-Dichlorophenoxyacetic Acid

Common Name: 2,4-D (includes parent acid as well as salt, amine and ester derivatives)

Trade Name: 2,4-D is available under a large selection of trade names, most often formulated as an inorganic salt, amine or ester.

EPA Chemical Code: 030001 (Acid)

Chemical Abstracts Service (CAS) Number: 94-75-7 (Acid)

Year of Initial Registration: 1948

Pesticide Type: Herbicide; Plant Growth Regulator.

Chemical Family: Chlorinated phenoxy

U.S. and Foreign Producers: 2,4-D technical products are manufactured by a large number of companies, both U.S. and foreign.

## USE PATTERNS AND FORMULATIONS

Registered Uses: Terrestrial, food and nonfood; aquatic, food and nonfood; domestic; and forestry.

Predominant Uses: Postemergent weed control in agricultural crops (approximately 57 percent of total usage; over 45 percent of total usage is on wheat and corn; 20 percent of total usage on pastures and rangelands; other major crops are sorghum, other small grains, rice and sugarcane); the remainder is used on noncrop areas, with a small amount used as a plant growth regulator (in filberts, citrus and potatoes).

Formulation Types Registered: Granular; amine and ester liquids; aerosol spray (foam).

Methods of Application: Aerial and ground equipment, knapsack sprayers, pressure and hose-end applicators, and lawn spreaders.

## SCIENCE FINDINGS

Summary Science Statement: The Agency's Office of Pesticide Programs (OPP) has classified 2,4-D as a Group D oncogen (not classifiable as to human carcinogenicity) because existing data are inadequate to assess the carcinogenic potential of 2,4-D. Accidental human poisoning with 2,4-D, which resulted in severe neurotoxicity, has been reported; adequate neurotoxicity studies are not available. While published data indicate that 2,4-D may be teratogenic, an acceptable rat teratology study is negative; a study in rabbits is needed.

2,4-D is often formulated as various esters and amines. These formulations may affect the physical characteristics, biological activity and environmental fate of the parent compound. Data are needed on each ester and amine before the Agency can completely assess 2,4-D.

Although laboratory data demonstrate that 2,4-D is mobile in soils, its potential to contaminate groundwater is limited by its rapid rate of degradation and uptake by target plants. However, residues of 2,4-D have been detected in groundwater, mostly from point sources, such as mixing, loading and disposal.

Certain formulations of 2,4-D are highly toxic to fish and/or aquatic invertebrates. Other formulations, for which the Agency has data, are in the range of moderately toxic to practically nontoxic to nontarget organisms. The Office of Endangered Species has issued biological opinions indicating that certain endangered species may be in jeopardy from the use of 2,4-D.

Chemical Characteristics (Acid):

Physical state - Flakes, powder, and crystalline powder and solid
Color - White to light tan
Odor - Phenolic to odorless
Melting point - 135-142$^{o}$C
Boiling point - 160$^{o}$C at 0.4 mm Hg
Solubility - Soluble in acetone, ethanol, aqueous alkali, alcohols, diethyl ether, ethyl ether,

isopropanol, methyl isobutyl ketone, most organic solvents; insoluble in benzene, petroleum oils
Vapor pressure - 0.4 mm Hg at 160°C
Stability - Stable to melting point

Toxicology Characteristics (Acid, except as noted):

Acute Toxicity:

2,4-D Acid -

Oral (rat): 639 mg/kg (males); 764 mg/kg (females); Toxicity Category III[1]

Inhalation (rat): 1.79 mg/L; Toxicity Category III

Dermal Sensitization (guinea pig): Not a sensitizer.

2,4-D Sodium Salt -

Oral (rat): 876 mg/kg (males); 975 mg/kg (females); Toxicity Category III

Dermal (rat): >2000 mg/kg; Toxicity Category III

Diethanolamine Salt (Manufacturing-Use Product) -

Oral (rat): >2000 mg/kg (males); 1605 mg/kg (females); Toxicity Category III

Dermal (rabbit): >2000 mg/kg (males and females); Toxicity Category III

Inhalation (rat): >3.8 mg/L; Toxicity Category III

Primary Eye (rabbit): Severe irritation and corneal ulcer not resolved 21 days post-treatment; Toxicity Category I

Primary Dermal (rabbit): No signs of dermal irritation; Toxicity Category IV

Dermal Sensitization (guinea pig): Not a dermal sensitizer.

Butoxyethyl Ester -

Oral (rat): 866 mg/kg; Toxicity Category III

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[1]For a description of Toxicity Categories, see 40 CFR 156.10.

Dermal (rabbit): >2000 mg/kg (females: 1829 (mg/kg (males); Toxicity Category III

Inhalation (rat): >4.6 mg/L; Toxicity Category III

Primary Eye (rabbit): Very mild eye irritation resolved in 72 hours; Toxicity Category III

Primary Dermal (rabbit): Very slight erythema cleared in 72 hours; Toxicity Category III.

Dermal Sensitization (guinea pig): Was a sensitizer in two tests and not a sensitizer in a third test.

Isooctyl Ester -

Oral (rat): 982 mg/kg (males); >720 <864 mg/kg (females); Toxicity Category III

Dermal (rabbit): >2000 mg/kg; Toxicity Category III

Isobutyl Ester -

Oral (rat): 700 mg/kg (males); 553 mg/kg (females); Toxicity Category III

Dermal (rabbit): >2000 mg/kg; Toxicity Category III

Isopropyl Ester -

Oral (rat): 640 mg/kg (males); 440 mg/kg (females); Toxicity Category II

Dermal (rabbit): >2000 mg/kg; Toxicity Category III

Inhalation (rat): >4.97 mg/L; Toxicity Category III

Primary eye (rabbit): All irritation cleared at 4 days; Toxicity Category III

Primary dermal (rabbit): No irritation at 72 hours; Toxicity Category IV

Dermal Sensitization (guinea pig): Nonsensitizer

Subchronic Toxicity: No acceptable data are available on 2,4-D. The requirement for subchronic oral studies on the acid is waived because chronic studies are required; a subchronic dermal study is required. Subchronic studies are required for the esters and amines.

Chronic Toxicity:

Oncogenicity (rats): No observed effects level (NOEL) for systemic effects - 1 mg/kg/day; lowest observed effects level (LOEL) for systemic effects - 5 mg/kg/day; further evaluation needed to determine if maximum tolerated dose was reached.

Oncogenicity (mice): NOEL for systemic effects - 1 mg/kg/day; LOEL for systemic effects - 15 mg/kg/day; further evaluation needed to determine if maximum tolerated dose was reached.

Teratology (rats): Fetotoxicity (delayed ossification) LOEL 75 mg/kg/day and NOEL 25 mg/kg/day; Maternal toxicity NOEL 75 mg/kg/day (highest dose tested).

Reproduction (rats): NOEL 5 mg/kg/day.

Major Routes of Exposure: The major route of exposure is dermal; respiratory exposure is negligible.

Physiological and Behavioral Characteristics:

Foliar Absorption: 2,4-D is absorbed through the roots and/or leaves depending upon the type of formulation. A rain-free period of 4 to 6 hours usually is adequate for uptake.

Translocation: Following foliar absorption, 2,4-D translocates within the phloem, probably moving with the food material. Following root absorption, it may move upward in the transpiration stream. Translocation rate is influenced by the growth rate of the plant. Accumulation occurs principally at the rapid growth regions of shoots and roots.

Mechanism of Pesticide Action: 2,4-D acid stimulates nucleic acid and protein synthesis affecting the activity of enzymes, respiration and cell division. Broadleaf plants exhibit malformed leaves, stems and roots.

Environmental Characteristics:

Absorption and Leaching: 2,4-D is mobile to highly mobile in five soil types. Based on available data, aged 2,4-D residues are only slightly mobile.

Microbial Breakdown: 2,4-D degrades rapidly in aerobic silty clay and loam soil systems.

Bioaccumulation: Available data indicate a low potential for 2,4-D to accumulate in fish.

Resultant Average Persistence: In aerobic silty clay and loam soils, 1.9-2.2 percent of applied 2,4-D remained at 51 days post-treatment; in four other soils, only 0.7-2.5 percent remained at 150 days post-treatment.

Environmental Fate and Surface and Groundwater Contamination Concerns: Although laboratory data demonstrate that 2,4-D is mobile in soils, its potential to contaminate groundwater is limited by its rapid rate of degradation and uptake by target plants. However, residues of 2,4-D have been detected in groundwater, mostly from point sources, such as mixing, loading and disposal.

Exposure of Humans and Nontarget Organisms: Accidental human poisoning with 2,4-D, which resulted in severe neurotoxicity, has been reported. Reports have been received concerning off-target movement of 2,4-D resulting in damage to crops or other desirable plants.

Exposure during Reentry Operations: Based on available data, 2,4-D products are of low toxicity (Toxicity Categories III and IV). Because of these low levels of toxicity, reentry is not a concern.

Ecological Characteristics (detailed information can be obtained from the Registration Standard):

Avian Toxicity: Acceptable data indicate that 2,4-D acid can be characterized as moderately toxic to practically nontoxic to avian species on an acute basis. Butyl ester can be characterized as practically nontoxic on an acute and chronic basis.

Fish Toxicity: Acceptable data indicate that 2,4-D acid and certain of its salts, esters and amines can be characterized in the range of moderately toxic to practically nontoxic to fish. However, the compounds N-oleyl-1,3-propylenediamine salt, N,N-dimethyloleyl-linoleylamine, butyl ester, butoxyethanol ester and propylene glycol butyl ether ester can be characterized as highly toxic to fish, based on the following toxicity values:

| | |
|---|---|
| N-oleyl-1,3-propylene-diamine salt | 0.3 ppm (bluegill sunfish) |
| | 0.8 ppm (channel catfish) |

| | |
|---|---|
| N,N-dimethyloleyl-linoleylamine | 0.64 ppm (rainbow trout) |
| Butyl ester | 0.49-2.82 ppm (cutthroat trout) |
| | 0.5-2.8 ppm (lake trout) |
| | 0.4-0.96 ppm (rainbow trout) |
| | 0.29-0.3 ppm (bluegill sunfish) |
| Butoxyethanol ester | 0.65 ppm (rainbow trout) |
| | 0.76-1.2 ppm (bluegill sunfish) |
| | 3.3 ppm (fathead minnow) |
| | 0.78-1.35 ppm (channel catfish) |
| Butoxypropyl ester | 5.4 ppm (rainbow trout) |
| Propylene glycol butyl ether ester | 0.33-2.8 ppm (cutthroat trout) |
| | 0.39-2.93 ppm (lake trout) |
| | 0.95-1.44 ppm (rainbow trout) |
| | 0.56-0.67 ppm (bluegill sunfish) |

Freshwater Invertebrates Toxicity: Of those compounds for which the Agency has data, reported toxicity values indicate that the compounds can be characterized as slightly toxic to practically nontoxic, excepted as noted below. The compounds set forth below have toxicity values which characterize them as highly toxic to aquatic invertebrates.

| | |
|---|---|
| Dimethylamine | 0.15 ppm (grass shrimp) |
| Isooctyl ester | 0.5 ppm (waterflea) |
| Butoxyethanol ester | 1.7-6.4 ppm (waterflea) |
| | 2.2 ppm (seed shrimp) |
| | 2.6 ppm (sow bug) |
| | 0.44-6.1 ppm (side swimmer) |
| | 0.39-0.79 ppm (midge) |
| Propylene glycol butyl ether ester | 0.1-14 ppm (waterflea) |
| | 0.42 ppm (seed shrimp) |

Estuarine and Marine Organisms Toxicity: Acceptable data are available only for the butoxyethanol ester which report toxicity values of 5.0 mg/L (longnose killifish), 2.6 mg/L (Eastern oyster) and 5.6 mg/L (brown shrimp), which indicate that the material is moderately toxic to estuarine and marine organisms.

Effects on Plants: Limited plant protection studies are available. In a spray drift study, two application methods were compared as to quantity and pattern of deposition. No difference was found between the amine derivatives (diethanolamine and dimethylamine). With these amines, drift was observed beyond 225 feet from the site of

application. No residues, attributable to drift, were found when applied postemergent to wheat or corn.

The toxicity of butoxyethanol ester was tested on four species of algae. Toxicity values ranged from 75 mg/L to 150 mg/L.

Nontarget Insects: There is sufficient information to characterize 2,4-D as relatively nontoxic to honey bees, when bees are exposed to direct treatment.

Potential Problems Related to Endangered Species: The Office of Endangered Species has determined that certain uses of 2,4-D may jeopardize the continued existence of endangered species or critical habitat of certain endangered species.

Tolerance Assessment:

Tolerances Established: Tolerances and food and feed additive regulations have been established for residues of 2,4-D in a variety of raw agricultural commodities and meat byproducts (40 CFR 180.142), and in processed food (40 CFR 185.1450) and feed (40 CFR 186.1450).

Results of Tolerance Assessment: A provisional acceptable daily intake (PADI) of 0.003 mg/kg/day for 2,4-D acid has been established based on a two-year rat feeding study. Compound-related effects were observed in the kidneys of both male and female rats. The LOEL was 5 mg/kg/day and the NOEL was 1 mg/kg/day. An uncertainty factor of 100 was used to account for the inter- and intraspecies differences. An additional uncertainty factor of 3 was used since there is no dog study available and no information available that indicates the dog is less sensitive than the rat.

Reported Pesticide Incidents: Based on the Pesticide Incident Monitoring System files, covering the period 1966 to 1979, reports were received concerning the off-target movement of 2,4-D in unspecified formulations, esters and amines. The incidents involved drift from aerial (173 reports) and ground (104 reports) applications, as well as volatilization and drift (35 reports) and resulted in damage to off-target crops or other desirable plants.

## SUMMARY OF REGULATORY POSITION AND RATIONALE

Summary of Agency Position: OPP has classified 2,4-D as a Group D oncogen (not classifiable as to human carcinogenicity). EPA is, however, requiring additional data, including additional information on oncogenicity and teratogenicity and neurotoxicity studies, for further evaluation of 2,4-D. Data are being required on the ester and amine formulations of 2,4-D as well as on the acid. EPA will not establish any significant new food use tolerances or register any significant new uses at this time.

Additional data are needed to thoroughly evaluate the ecological effects of 2,4-D and its potential to contaminate groundwater.

EPA is developing a program to reduce or eliminate exposure to endangered species from the use of 2,4-D to a point where use does not result in jeopardy, and will issue notice of any labeling revisions when the program is developed. Endangered species labeling is not required at this time.

Unique Warning Statements Required on Labels:

Manufacturing-Use Products: "Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public waters unless this product is specifically identified and addressed in an NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA."

End-Use Products:

Aquatic Uses. "Drift or runoff may adversely affect nontarget plants. Do not apply directly to water except as specified on this label. Do not contaminate water when disposing of equipment washwaters."

Nonaquatic Uses. "Drift or runoff may adversely affect nontarget plants. Do not apply directly to water or wetlands (swamps, bogs, marshes, and potholes). Do not contaminate water when disposing of equipment washwaters."

End-Use Products - Certain Formulations: End-use products containing the following formulations must

contain the above environmental precautions modified to indicate that the product is toxic either to fish or aquatic invertebrates:

Toxic to Fish - N-Oleyl-1,3-Propylenediamine salt
N,N-Dimethyloleyl-Linoleylamine
Butyl ester
Butoxylethanol ester
Propylene glycol butyl ether ester

Toxic to Aquatic Invertebrates - Dimethylamine
Isooctyl ester

All End-Use Products: The following statements are required in the use directions for all end-use products:

Liquid Formulations: "This product can reach groundwater from mixing and loading. To minimize groundwater contamination from spills during mixing, loading and cleaning of equipment, take the following steps:

"Mixing and Loading: When mixing, loading or applying this product, wear chemical resistant gloves. Wash nondisposable gloves thoroughly with soap and water before removing.

"The mixing and loading of spray mixtures into the spray equipment must be carried out on an impervious pad (i.e., concrete slab, plastic sheeting) large enough to catch any spilled material. If spills occur, contain the spill by using an absorbent material (e.g, sand, earth or synthetic absorbent). Dispose of the contaminated absorbent material by placing in a plastic bag and following disposal instructions on this label.

"Triple rinse empty containers and add the rinsate to the mixing tank.

"Cleaning of Equipment: When cleaning equipment, do not pour the washwater on the ground; spray or drain over a large area away from wells and other water sources."

Granular Formulations: "This product can reach groundwater from improper handling. To minimize groundwater contamination from spills during loading and cleaning of equipment, take the following steps:

"Handling: When handling this product, wear chemical resistant gloves. Wash nondisposable

contain the above environmental precautions modified to indicate that the product is toxic either to fish or aquatic invertebrates:

Toxic to Fish - N-Oleyl-1,3-Propylenediamine salt
N,N-Dimethyloleyl-Linoleylamine
Butyl ester
Butoxylethanol ester
Propylene glycol butyl ether ester

Toxic to Aquatic Invertebrates - Dimethylamine
Isooctyl ester

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"Mixing and Loading: When mixing, loading or applying this product, wear chemical resistant gloves. Wash nondisposable gloves thoroughly with soap and water before removing.

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"Triple rinse empty containers and add the rinsate to the mixing tank.

"Cleaning of Equipment: When cleaning equipment, do not pour the washwater on the ground; spray or drain over a large area away from wells and other water sources."

Granular Formulations: "This product can reach groundwater from improper handling. To minimize groundwater contamination from spills during loading and cleaning of equipment, take the following steps:

"Handling: When handling this product, wear chemical resistant gloves. Wash nondisposable

gloves thoroughly with soap and water before removing. If spills occur, collect the material and dispose of by following disposal instructions on this label.

"Cleaning of Equipment: When cleaning equipment, do not pour the washwater on the ground; spray or drain over a large area away from wells and other water sources."

End-Use Products - Certain Food/Feed Uses. Labels for products registered for certain food/feed uses must contain revised use directions pertaining to appropriate preharvest, pregrazing and preslaughter intervals; allowable range of diluent; and/or maximum seasonal application rate and/or number of applications.

SUMMARY OF MAJOR DATA GAPS. The following data are required for 2,4-D acid. The Agency is also requiring data on each individual ester and amine of 2,4-D. Specific requirements are detailed in the Data Tables, Appendix I of the Registration Standard, which can be obtained from the Product Manager listed below.

| Study | Due Date - From Date of Standard |
|---|---|
| Product Chemistry | 6-15 months |
| Residue Chemistry:<br>Plant and animal metabolism<br>Analytical methods<br>Residue studies | 18-24 months |
| Toxicology:<br>Primary Eye and Dermal Irritation<br>21-Day Dermal<br>Chronic Toxicity (nonrodent)<br>Teratogenicity (rabbit)<br>Mutagenicity<br>Metabolism<br>Special Dermal (Neurotoxicity)<br>Reserved: Oncogenicity (two species) | 9-50 months |
| Ecological Effects:<br>Avian Dietary<br>Aquatic Organism (freshwater fish and invertebrates; estuarine and marine organisms; accumulation)<br>Phytotoxicity (Tier II) | 9-18 months |

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| Study | Due Date - From Date of Standard |
|---|---|
| Environmental Fate: | 9-50 months |
| Hydrolysis | |
| Photodegradation (water, soil, air) | |
| Metabolism (anaerobic soil; aerobic and anaerobic aquatic) | |
| Leaching and Adsorption/Desorption | |
| Volatility (lab and field) | |
| Dissipation (soil, aquatic and forestry) | |
| Accumulation (confined rotational crops; irrigated crops; fish and aquatic nontarget organisms) | |
| Spray drift | |

CONTACT PERSON AT EPA: Mr. Richard Mountfort
Product Manager (Team 23)
Fungicide-Herbicide Branch
Registration Division (TS-767C)
Office of Pesticide Programs, EPA
Washington, DC 20460

Telephone: (703) 557-1830

DISCLAIMER: The information in this Pesticide Fact Sheet is a summary only and may not be used to fulfill data requirements for pesticide registration and reregistration.